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REPORT ON FUEL EFFICIENCY TRIAL
MINE HAUL TRUCK

THIESS CONTRACTORS PTY LTD
GRANNY SMITH MINESITE

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Report prepared by:

R.A. Platt
Fuel Technology Pty Ltd
70 Adelaide Street
FREMANTLE WA 6160

Tel: (09) 335 6899
Fax: (09) 430 5403

ACN 005 945 915

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SUMMARY

We have successfully concluded a set of carefully supervised, comparative dynamic fuel consumption trials using a Caterpillar 777B mine haul truck working with an operational load over a measured open pit circuit.

The purpose of this elaborately instrumented trial was to demonstrate to the management of Thiess Contractors Pty Ltd the economic value of FTC fuel treatment under operating conditions at a minesite.

A second purpose of this trial was to demonstrate to what extent static testing of treated and untreated fuel consumption by truck engines loaded against wheel brakes gives a fair assessment of the comparative fuel consumption rates by the same type of trucks working through a mine operating cycle.

The results of the subject dynamic field trial are reported in detail on the pages that follow. They show that:

1. With a few noted exceptions the trial data have uniformity and reproduceability which give confidence to the measuring technique and test protocol.

2. The measured difference in fuel consumption between untreated diesel baseline tests and those run later using the same diesel fuel treated with FTC fuel catalyst demonstrates a 6-7% reduction in fuel consumption as a result of fuel treatment at low engine loadings and 5% at higher engine loads.

3. These measured reductions in operational fuel consumption compare favourably with those measured in the 49 fleet trials run by standard engineering static tests listed in our published data base ***TEN YEARS OF TESTING***.

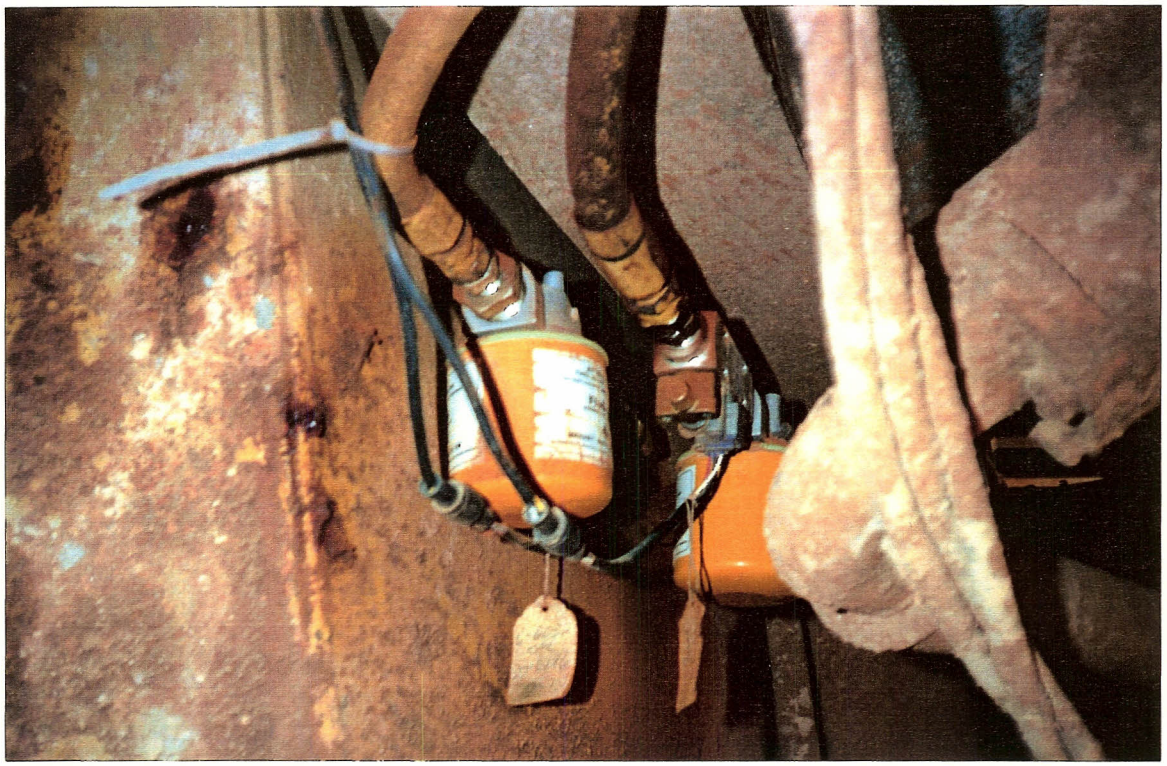

Photo 1. Flowscan transducers fitted adjacent to fuel tank. Measuring flow to and return from engine.

Photo 2. Data recording equipment set up in driver's cab. Minitrol volume recorder, digital thermometer, stop watch and data work sheets.

TEST PROCEDURE

The test procedure involved running Caterpillar 777B Haul Truck 9653 over a measured route and carrying a measured payload. The test truck was fitted with two Flowscan 233F transducers, interconnected to the supply and return fuel lines; *refer Photo 1.*

A thermocouple probe was fitted to the primary fuel filter, and the flow transducers and thermocouple were connected to instrumentation mounted in the vehicle cab; *refer Photo 2.*

Prior to the trial the truck was weighed unloaded on the platform scales. The truck was then loaded and reweighed; *refer Photo 3.*

The truck test circuit was measured by means of a surveyors wheel. The test circuit comprised three sectors:

Sector A - Ramp Haul	was a measured distance from the pit floor to a point at top of the waste dump.A distance of 1562 meters.
Sector B - Waste Haul	was a measured distance from the top of the waste dump to a point 821 meters along the top of the dump.
Sector C - Waste Return	was the equal return distance as stated for Sector B.

The ramp return from top of waste dump to the pit floor provided too many driver variables to be assessed accurately and after the initial attempts of measuring elapsed time and fuel consumed indicated poor repeatability was not progressed. In order to provide repeatable measurements, the driver was instructed to drive the truck to the following guidelines:

Sector A - Ramp Haul	Lock transmission in second gear and maintain full throttle.
Sector B - Waste Haul	Hold transmission in sixth gear, maintain 2000 engine RPM and speed at 45 kph.
Sector C - Waste Return	Hold transmission in fifth gear, maintain 1800 engine RPM and speed at 30 kph.

TEST RESULTS

Baseline and treated fuel consumption in kilograms has been calculated for each haul sector A, B and C using the stabilised measurements of litres consumed, corrected for fuel temperature and density over the four days of trials. For much of each day the measured values recorded in the tables show good day to day reproduceability and correlation in the truck operation and performance over each sector of the measured circuit.

Using the stabilised data taken from the charts , Figures 1, 2, 3 and 4, the base-line and treated fuel consumption in kilograms has been calculated and recorded for each sector in the table below.

BASELINE	**A**	**B**	**C**	**TOTAL**
Day One	12.89	1.98	1.75	16.62
Day Two	13.11	1.97	1.72	16.80
Average kg	**13.00**	**1.98**	**1.74**	**16.71**
TREATED	**A**	**B**	**C**	**TOTAL**
Day One	12.47	1.86	1.62	15.95
Day Two	12.47	1.82	1.62	15.91
Average kg	**12.47**	**1.84**	**1.62**	**15.93**

In each case, the average fuel consumed during the treated fuel test is less than for the same sector during the baseline test. The percentage fuel saving result-ing from fuel treatment is tabulated below:

		A	**B**	**C**	**TOTAL**
BASELINE	kg	13.00	1.98	1.74	16.71
TREATED	kg	12.47	1.84	1.62	15.93
% Reduction		**4.1**	**6.8**	**6.6**	**4.7**

These results must be adjusted to reflect the approximate 3 tonne larger load carried by the truck during the treated tests. This correction is conservatively made by adjusting the baseline fuel consumed on sector A, the ramp haul, by bringing the haul time into line with that measured when the load carried up the ramp was 2.9 tonnes greater. Figure 5 compares these times showing the more heavily loaded treated fuel haul to take about five seconds longer.

Using data from Tables 1 and 2, the sector A consumption rate is calculated to be 0.029 kg per second. The five second correction to baseline consumption for the A sector and total circuit brings the average figures to 13.15 and 16.86 kg respectively and adjusts the fuel savings to:

Sector A	5.2%
Sector B	6.8%
Sector C	6.6%
Total Circuit	**5.5%**

Photo 3. Test truck being weighed on platform scale.

Photo 4. Granny Smith Open Pit. Test truck returning down the ramp.

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DYNAMIC FUEL CONSUMPTION TRIAL: **TABLE 1**

LOCATION: Placer Granny Smith Minesite, W.A.

Date: 15 May 1993 -- Day ONE Untreated Fuel Baseline Test

Equipment: **CAT 777B Dump Truck, Unit No. 9653**

Engine Hours:	Start: 17486	Finish: 17489	
Truck Weight:	Tare 69200 kg	**Truck Load:**	79600 kg GVW 148800 kg
Fuel Density at 15 deg. C:	0.848	**Tyre Pressure:**	110
Fuel Tank Capacity:	1200 L	**Air Filter Condition:**	Replaced

Haul Road Condition:	Dry
Weather/Wind Condition:	Sunny, dry, clear sky
Ambient Pressure:	977(1345H)975(1735H)

Distances travelled:

Ramp Haul A	1562 m
Waste Haul B	821 m
Pit Return C	821 m
Total	3204 m

Driving mode:	**Gear**	**rpm**	**Speed**
Ramp Haul A	2nd (flat)		Max.
Waste Haul B	6th (flat)	2000	45 km/h
Pit Return C	5th	1800	30 km/h

		Test Sector Measurements												**Adjusted Sector Value**			**Total**
		A				**A + B**				**C**				**kg**	**kg**	**kg**	**Run kg**
Run No.	**Start Time Clock**	Mins / Secs	L Fuel	Fuel Temp	Density Correc-tion	Mins / Secs	L Fuel	Fuel Temp	Density Correc-tion	Mins / Secs	L Fuel	Fuel Temp	Density Correc-tion	A	B	C	
1	1.35	7.31	10.86	39.70	0.831	8.43	12.53			1.43	1.44						
2	1.52	7.31	11.87	41.20	0.829	8.45	14.00			1.45	1.97						
3	2.10	7.29	15.48	43.50	0.828	8.44	17.80	44.40	0.827	1.45	2.14	44.60	0.826	12.82	1.92	1.77	16.50
4	2.35	7.31	15.68	45.90	0.826	8.44	18.00	46.80	0.825	1.43	2.18	47.10	0.825	12.95	1.91	1.80	16.66
5	2.50	7.29	15.66	47.50	0.824	8.43	18.05	48.60	0.824	1.44	2.25	48.60	0.824	12.90	1.97	1.85	16.73
6	3.07	7.29	15.77	49.30	0.823	8.42	18.12	50.00	0.823	1.43	2.17	50.10	0.823	12.98	1.93	1.79	16.70
7	3.22	7.30	15.77	50.60	0.822	8.42	18.09	51.30	0.823	1.44	2.08	51.40	0.822	12.96	1.91	1.71	16.58
8	3.40	7.30	15.48	51.80	0.821	8.43	18.00	52.40	0.821	1.45	1.98	52.40	0.821	12.71	2.07	1.63	16.40
9	3.55	7.31	15.62	52.80	0.820	8.44	18.12	53.50	0.820	1.44	2.06	53.50	0.820	12.81	2.05	1.69	16.55
10	4.13	7.30	15.80	53.80	0.820	8.44	18.35	54.40	0.820	1.44	2.14	54.30	0.820	12.96	2.09	1.75	16.80
11	4.30	7.31	16.47	54.70	0.819	8.45	19.15	55.20	0.819	1.44	2.09	55.10	0.819	13.49	2.19	1.71	17.40
12	4.47	7.30	18.88	55.30	0.819	8.44	22.09	55.80	0.819	1.45	2.91	55.70	0.819	15.46	2.63	2.38	20.48
13	5.03	7.30	20.88	55.80	0.819	8.43	24.22	56.40	0.818	1.44	2.98	56.10	0.818	17.10	2.73	2.44	22.27
14	5.22	7.29	22.02	56.00	0.818	8.43	25.39	56.70	0.818	1.45	3.18	56.40	0.818	18.01	2.76	2.60	23.37

COMPANY: THIESS CONTRACTORS

DYNAMIC FUEL CONSUMPTION TRIAL

TABLE 3

LOCATION: Placer Granny Smith Minesite, W.A.

Date: 26 June 1993 -- Day ONE Treated Fuel Test

Equipment: **CAT 777B Dump Truck, Unit No. 9653**

Engine Hours: Start: 18005 Finish: 18010

Truck Weight: Tare 69200 kg **Truck Load:** 82500 kg GVW 151700 kg

Fuel Density at 15 deg. C: 0.839 **Tyre Pressure:** 110

Fuel Tank Capacity: 1200 L **Air Filter Condition:** Replaced

Haul Road Condition: Wet at start

Weather/Wind Condition: Sunny after wet Friday, clear sky, strong head wind

Ambient Pressure: 967.5/970

Distances travelled:

Ramp Haul A	1562 m
Waste Haul B	821 m
Pit Return C	821 m
Total	3204 m

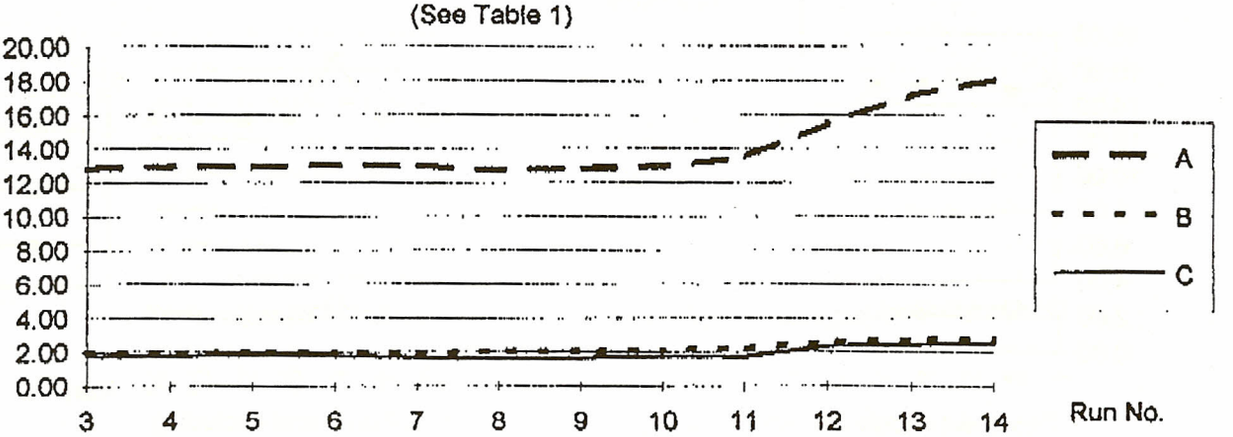
Driving mode:

	Gear	rpm	Speed
Ramp Haul A	2nd (flat)		Max.
Waste Haul B	6th (flat)	2000	45 km/h
Pit Return C	5th	1800	30 km/h

		Test Sector Measurements												Adjusted Sector Value			Total
		A				A + B				C				kg	kg	kg	Run kg
Run No.	Start Time Clock	Mins / Secs	L Fuel	Fuel Temp	Density Correc-tion	Mins / Secs	L Fuel	Fuel Temp	Density Correc-tion	Mins / Secs	L Fuel	Fuel Temp	Density Correc-tion	A	B	C	
1	10.50		18.99	19.90	0.834		22.38	21.00	0.833		2.12	22.23	0.833	15.84	2.82	1.77	20.43
2	11.15	7.35	17.68	23.90	0.833	8.52	20.74	24.80	0.832	1.45	2.05	26.10	0.832	14.73	2.55	1.71	18.98
3	12.55	7.36	15.49	36.00	0.825	8.53	17.79	36.60	0.824	1.45	2.03	37.50	0.824	12.78	1.90	1.67	16.35
4	1.15	7.35	15.13	38.70	0.823	8.50	17.42	39.70	0.822	1.42	2.02	40.00	0.822	12.45	1.88	1.66	15.99
5	1.35	7.36	15.14	41.00	0.821	8.50	17.40	41.90	0.821	1.43	1.96	41.90	0.821	12.43	1.86	1.61	15.89
6	2.00	7.37	15.24	43.60	0.820	8.49	17.46	44.40	0.819	1.43	1.95	44.60	0.819	12.50	1.82	1.60	15.91
7	2.20	7.35	15.22	45.90	0.818	8.50	17.46	46.70	0.817	1.42	1.96	47.00	0.817	12.45	1.83	1.60	15.88
8	2.40	7.34	15.27	47.90	0.816	8.50	17.55	48.90	0.816	1.42	1.98	48.70	0.816	12.46	1.86	1.62	15.94
9	3.00	7.34	15.31	49.50	0.815	8.50	17.62	50.20	0.814	1.43	2.00	50.40	0.814	12.48	1.88	1.63	15.99
10	3.15	7.36	15.32	51.10	0.814	8.48	17.58	51.50	0.814	1.43	2.01	51.80	0.814	12.47	1.84	1.64	15.95
11	3.35	7.35	15.35	52.50	0.813	8.48	17.64	52.70	0.813	1.42	2.00	53.10	0.813	12.48	1.86	1.63	15.97
12	3.55	7.34	15.38	53.50	0.812	8.49	17.66	53.50	0.812	1.42	2.01	53.90	0.812	12.49	1.85	1.63	15.97
13	4.15	7.33	15.37	54.50	0.812	8.48	17.69	54.70	0.811	1.43	1.98	54.70	0.811	12.48	1.88	1.61	15.97

FIGURE 1: Kg Fuel Consumption for Sectors A, B & C - Day 1 Baseline

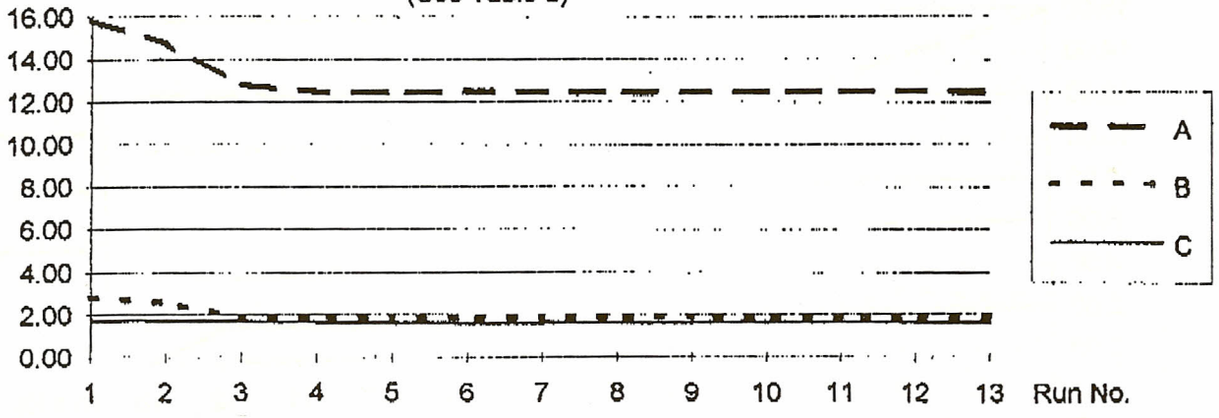
(See Table 1)



This chart shows from Run 3 through 10 before the driver reported break drag on Runs 11-14, Sector A consumption was 12.89 kg; B, 1.98 kg & C, 1.75 kg

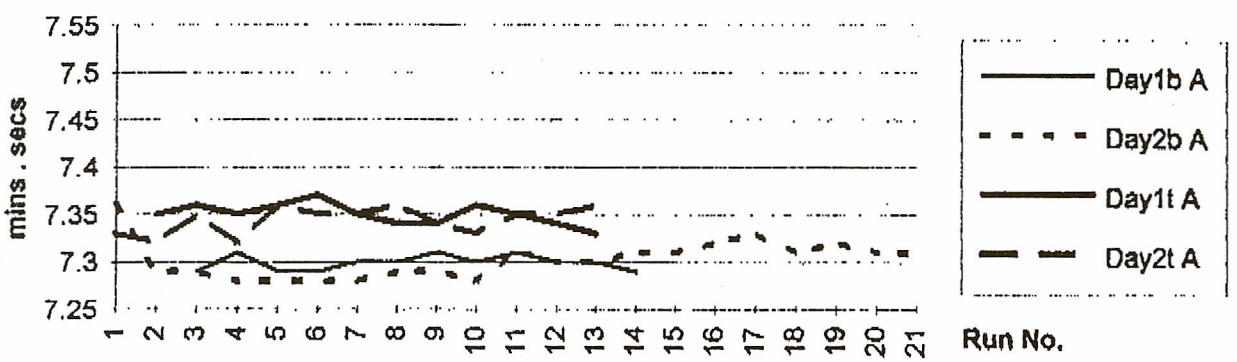
FIGURE 3: Kg Fuel Consumed for Sectors A, B & C - Day 1 Treated

(See Table 3)



This chart shows that after stabilising on Run 3, truck fuel consumption averaged 12.47 kg for Sector A, 1.86 kg on Sector B & 1.62 kg on Sector C

FIGURE 5: TIMES FOR BASELINE and TREATED TRUCK HAULS - SECTOR A



This Chart shows the increase in Sector A haul time resulting from the 2.9 tonne increase in the load during the Treated test period over the Baseline

Appendix "A"

HAUL TRUCK VOLUMETRIC FUEL MEASUREMENT PROCEDURE

HAUL TRUCK VOLUMETRIC FUEL MEASUREMENT PROCEDURE

Objective

To provide an alternative basis for measuring haul truck fuel consumption, where carbon balance measurement is not accepted and operating data is too variable to enable statistical analysis.

This method has elements of some approved SAE procedures and will enable fuel consumption measurement to be conducted under controlled operating conditions.

Equipment

Caterpillar are now marketing a Payload monitor, which can be fitted to all late model Caterpillar trucks. This equipment enables the operator to recall data for each operating cycle, including, load carried, cycle time loaded and unloaded, cycle speeds, engine RPM etc.

To enable a controlled test to be conducted the work done, load carried and distance travelled must be established. The Caterpillar Payload Monitor will enable assessment of load carried each cycle.

Alternatively, where Payload monitoring is not available, loads can be established by use of platform scales. For reliable efficiency studies to be conducted the truck load must be accurately established.

The distance over the test ramp will be provided by survey.

Fuel Flow to be measured by two (2) Flowscan 233F Transducers coupled to a Minitrol Dual Input counter and ratemeter with scaling & two presets.

Fuel Temperature/Density to be monitored.

a) Density By Calibrated Hydrometer & Thermometer in conjunction with Institute of Petroleum Density Correction Tables.

b) Fuel Operating Temperature by thermocouple probe and digital recorder.

A quartz crystal digital stop watch to be employed for timing each run.

Ambient Temperature to be checked each hour.

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At the completion of the days run, the performance will be assessed by converting the volume consumption to mass, by calculating the density at the observed temperature, and the extent of variation in readings noted.

Provided good repeatability is achieved within say ± 2%, a further set of readings to be taken on the second day to assess the reproducibility of the test method.

Results of the two days averaged recordings to be compared.

If the variation is greater than ± 2% the test should be aborted as unreliable. If less than ± 2% than the fuel to be treated with FTC for a minimum of 200 hours. The first tankful treated to be at ratio of 1:800.

After the 200 hours conditioning, the above test procedure will be repeated using the same driver and observers.

Conclusion

When the two sets of readings (untreated and treated) have been corrected for temperature and assessed the variation in TKPL (Tonne Kilometer per Litre) to be reported in detail, with the customers acknowledgement of the data accuracy and result.

As the ramp tests will involve maximum power the rate of fuel consumption treated and untreated should be identical. The increase in power to be achieved by FTC addition to the fuel, should reduce the ramp time and thus fuel consumed.

As the engine will be operating in its most efficient mode, an efficiency gain in the region 3% to 5% is expected. A higher gain is expected under the lower power condition hauling on the flat.